

Fig. 3

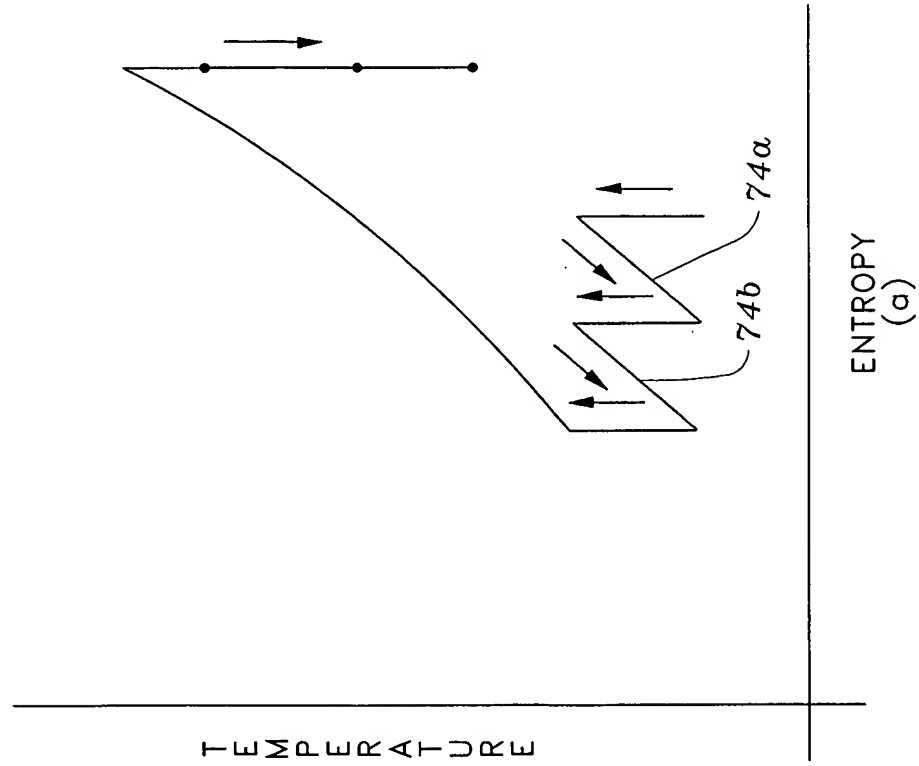


Fig. 4

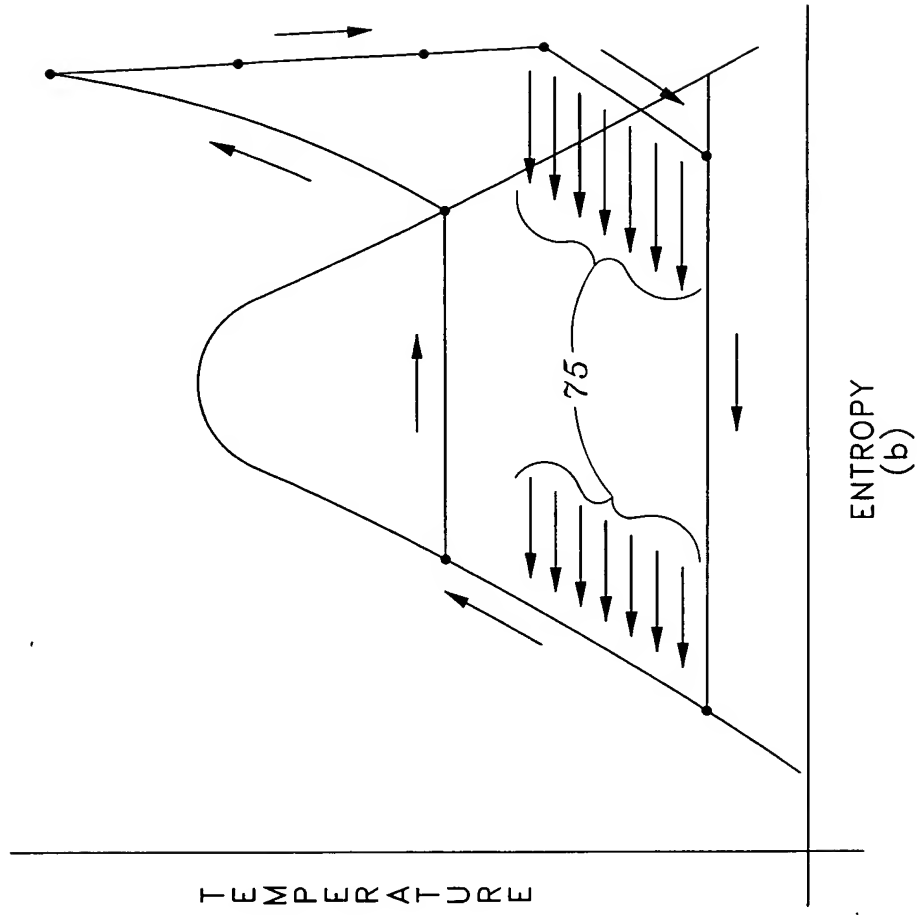


Fig. 5

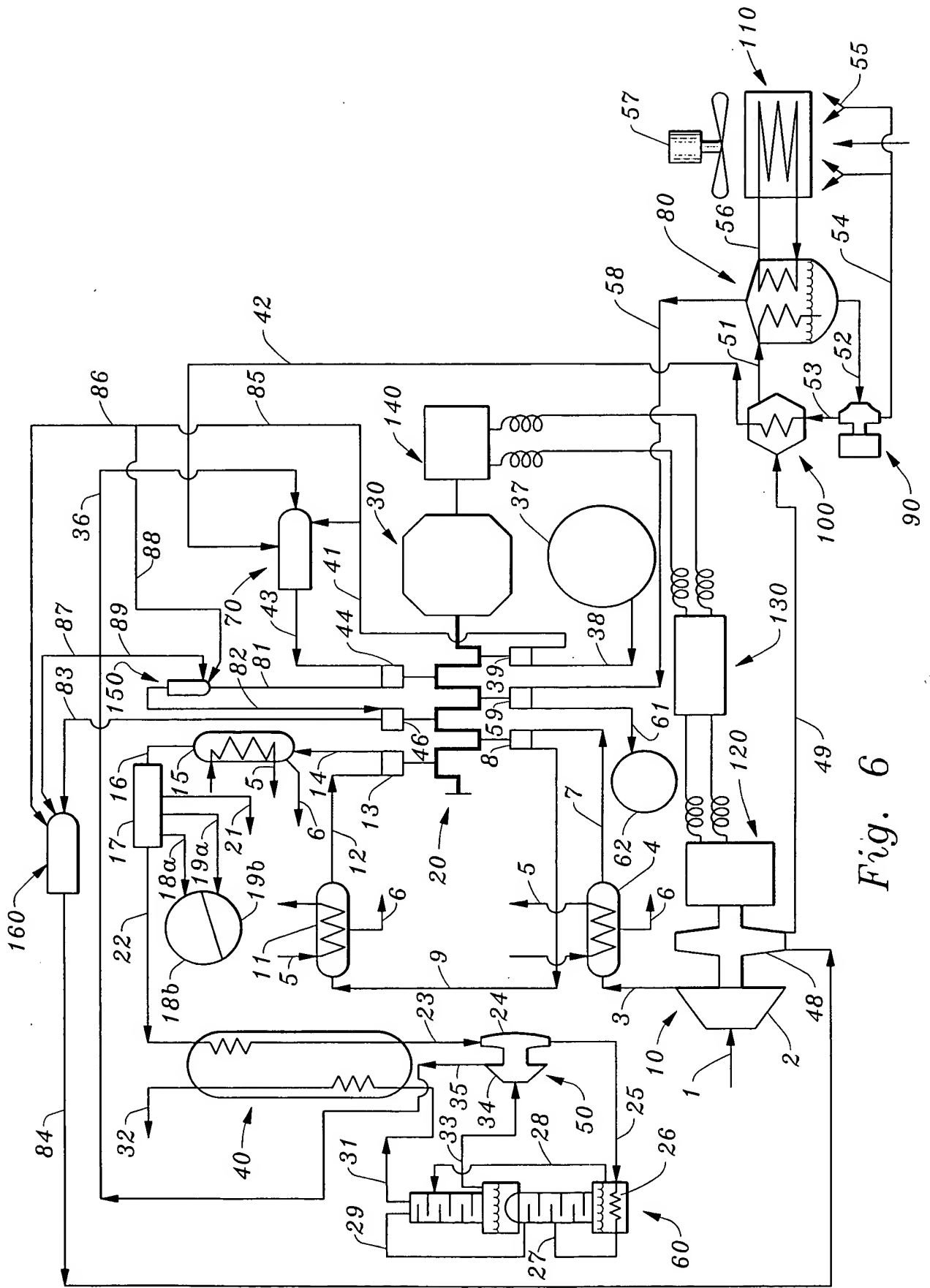


Fig. 6

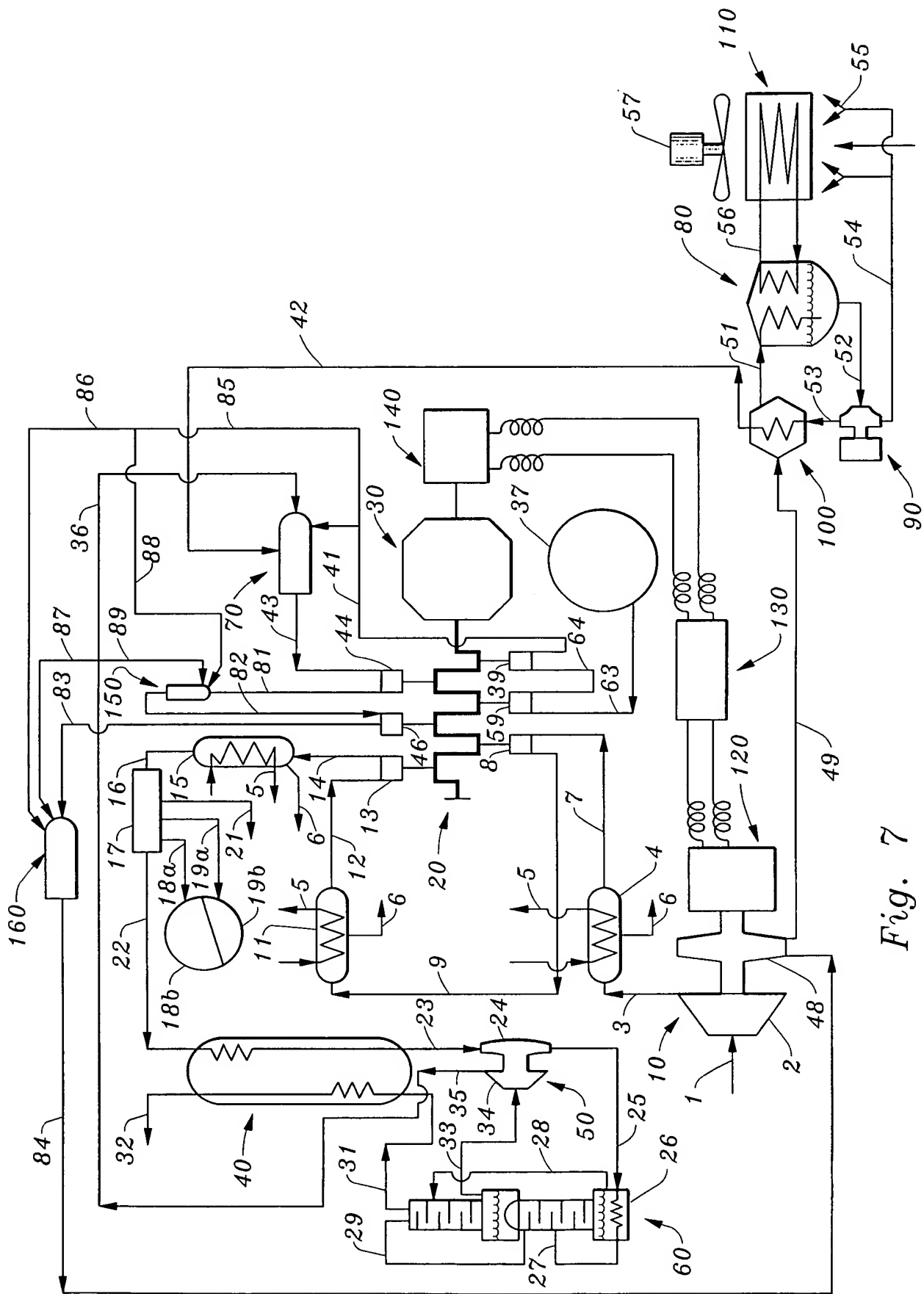
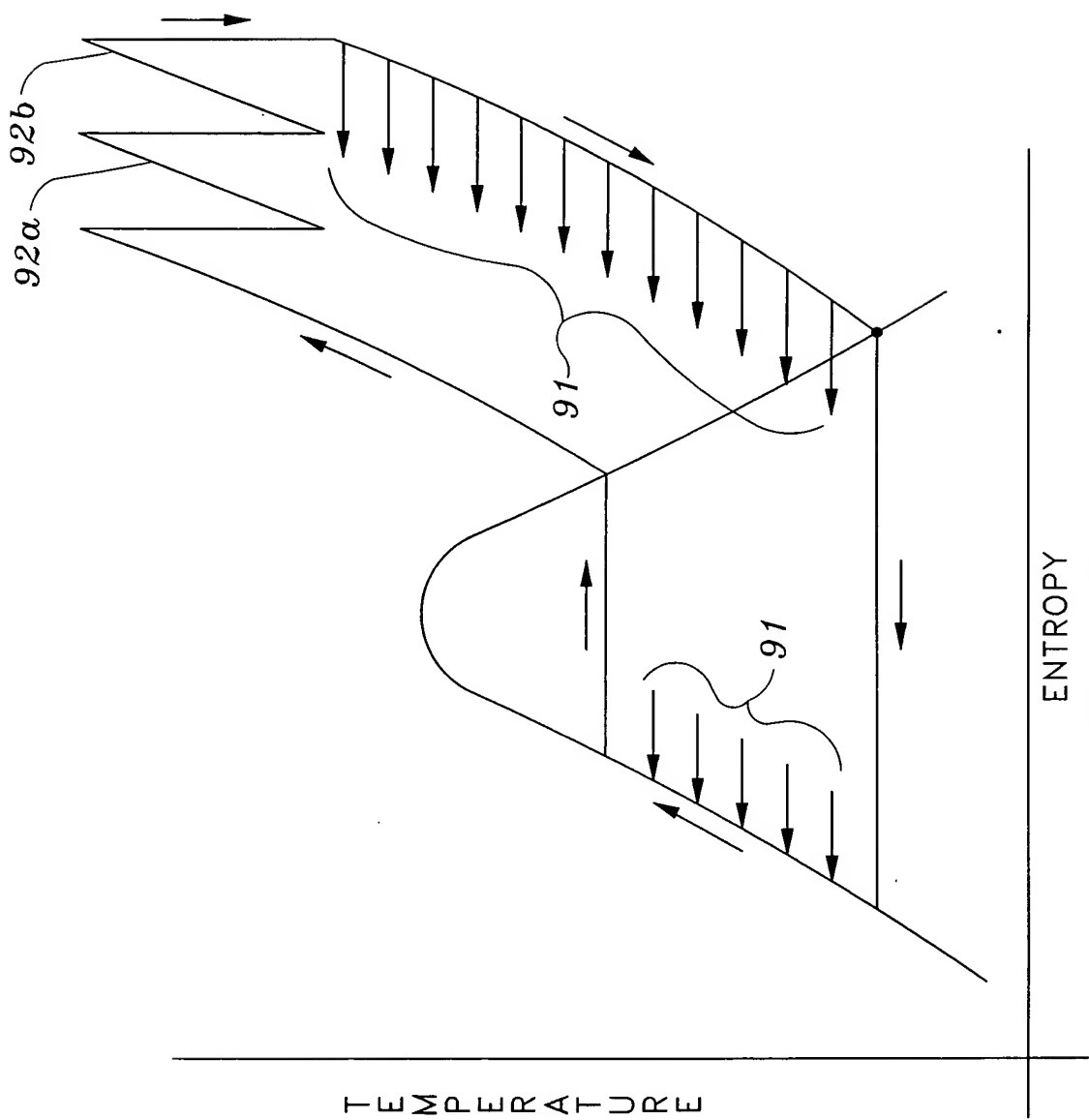


Fig. 7



ENTROPY  
Fig. 8

TEMPERATURE

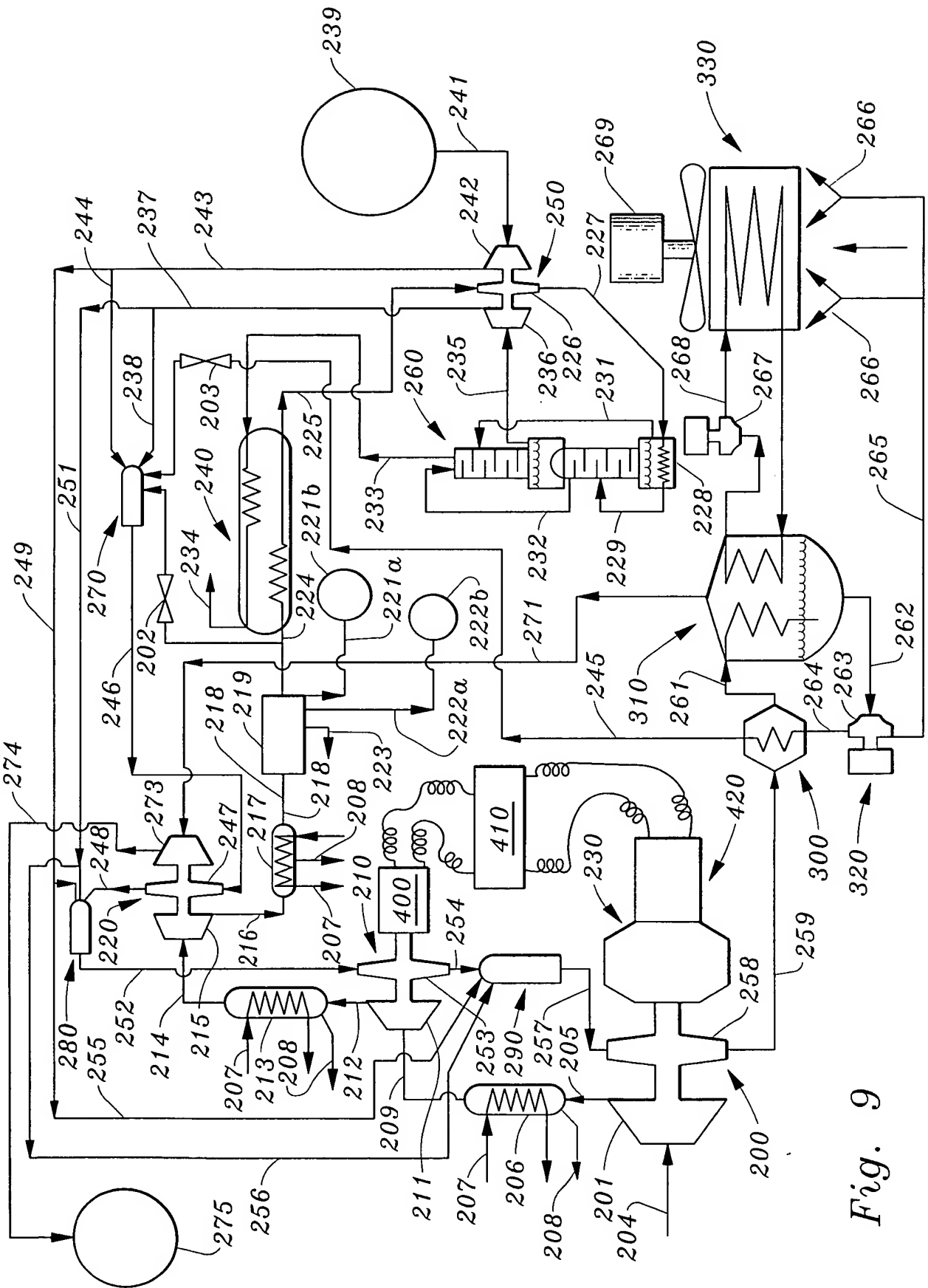


Fig. 9



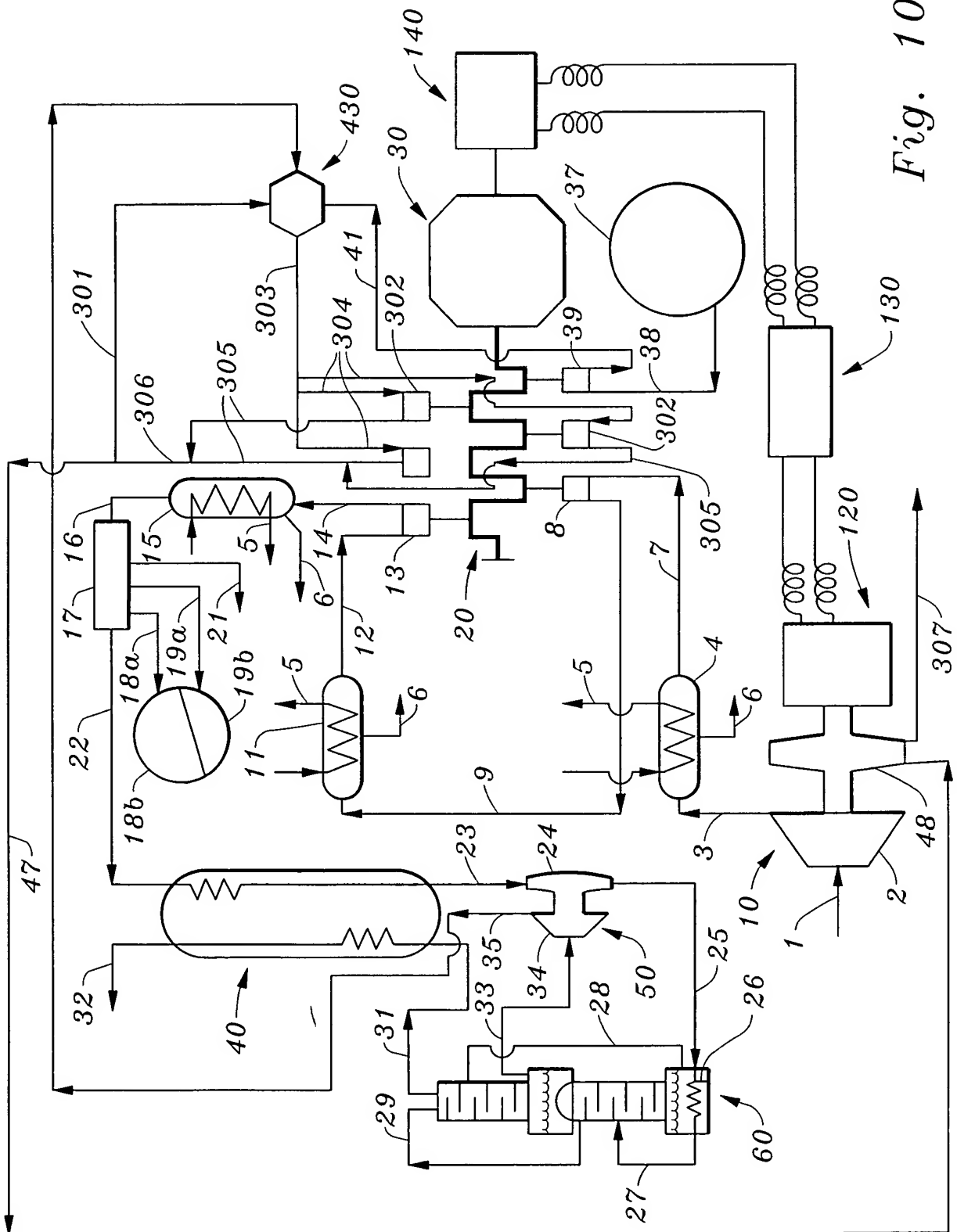


Fig. 10

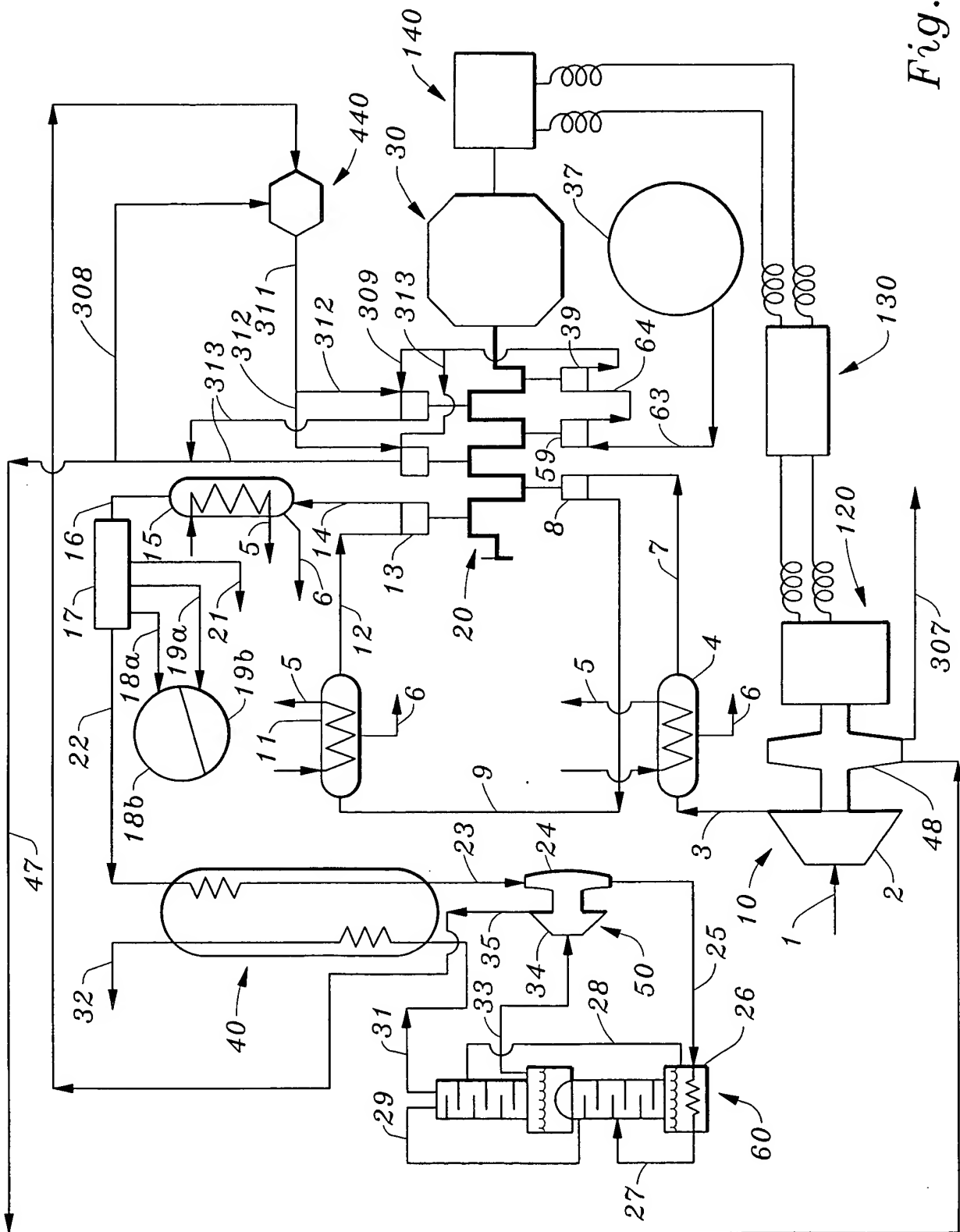


Fig. 11

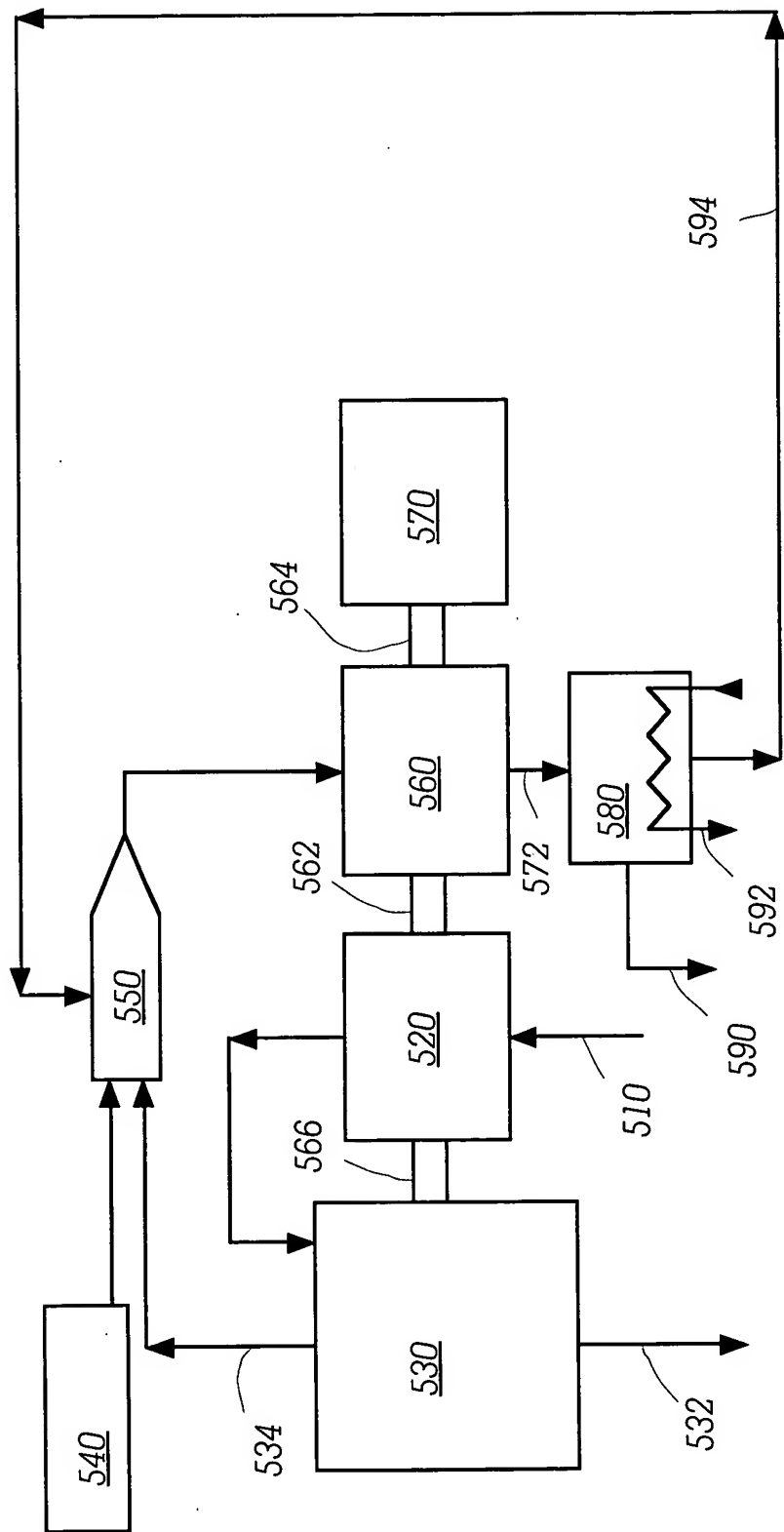


Fig. 12

500

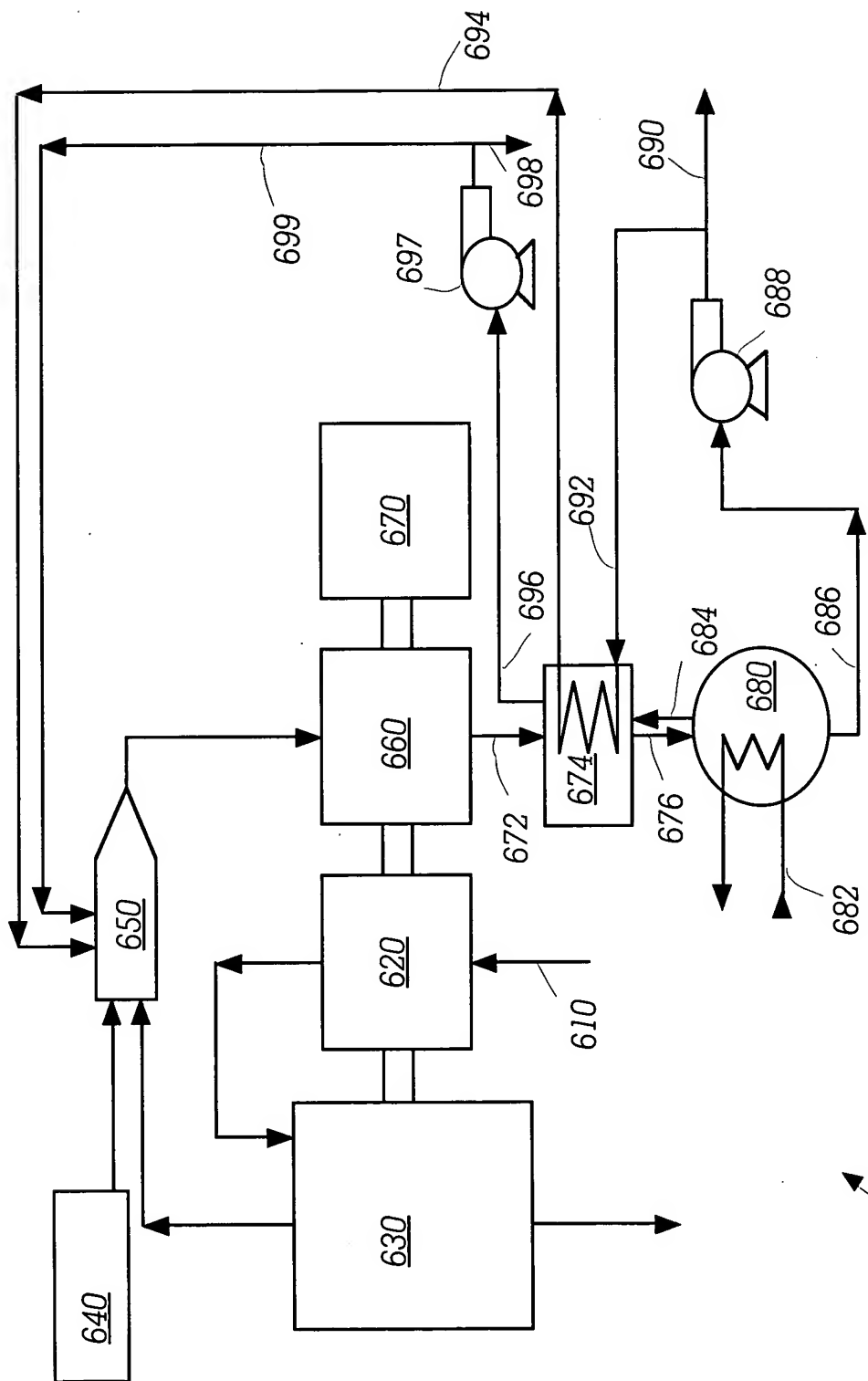


Fig. 13

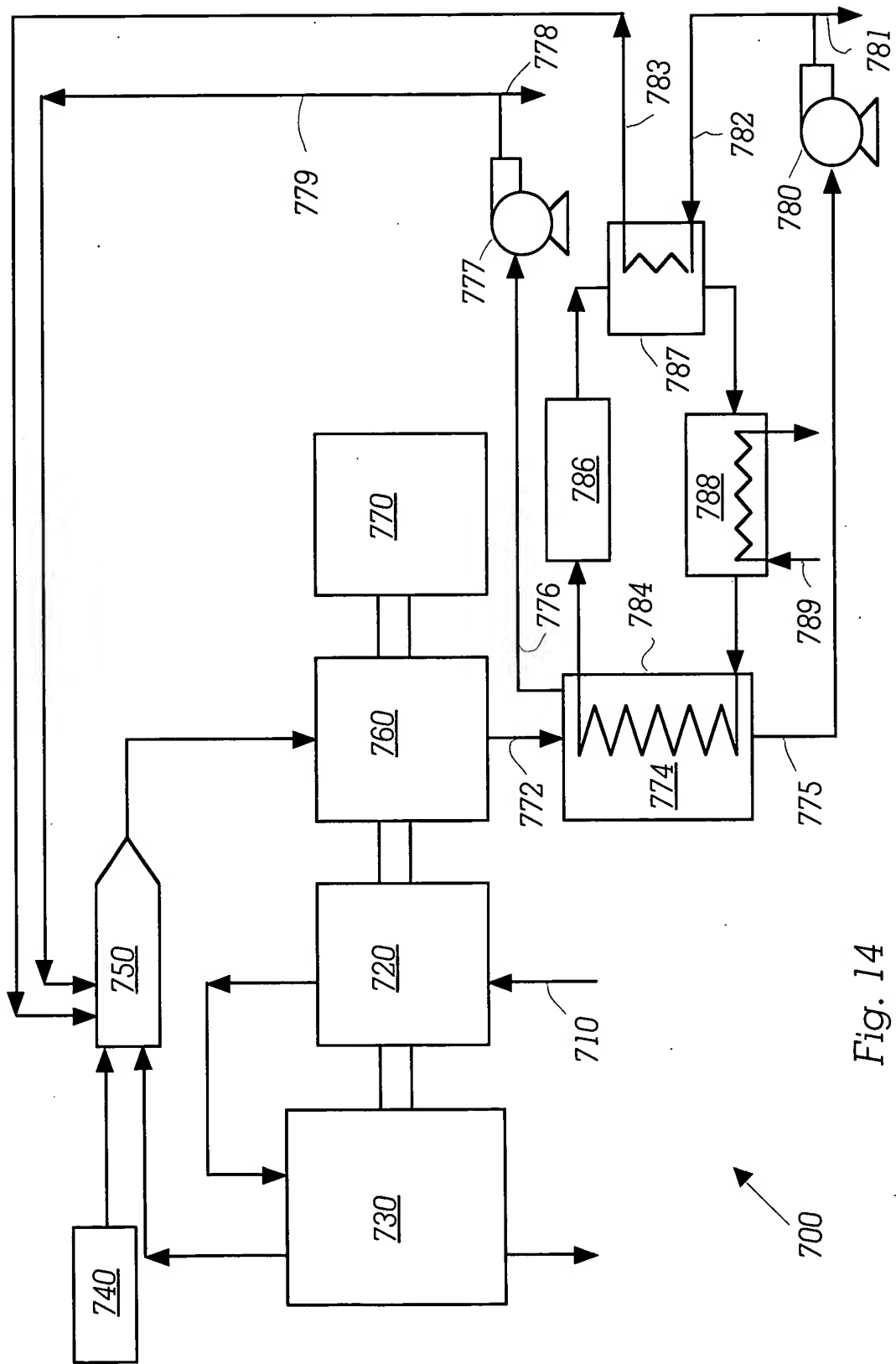


Fig. 14

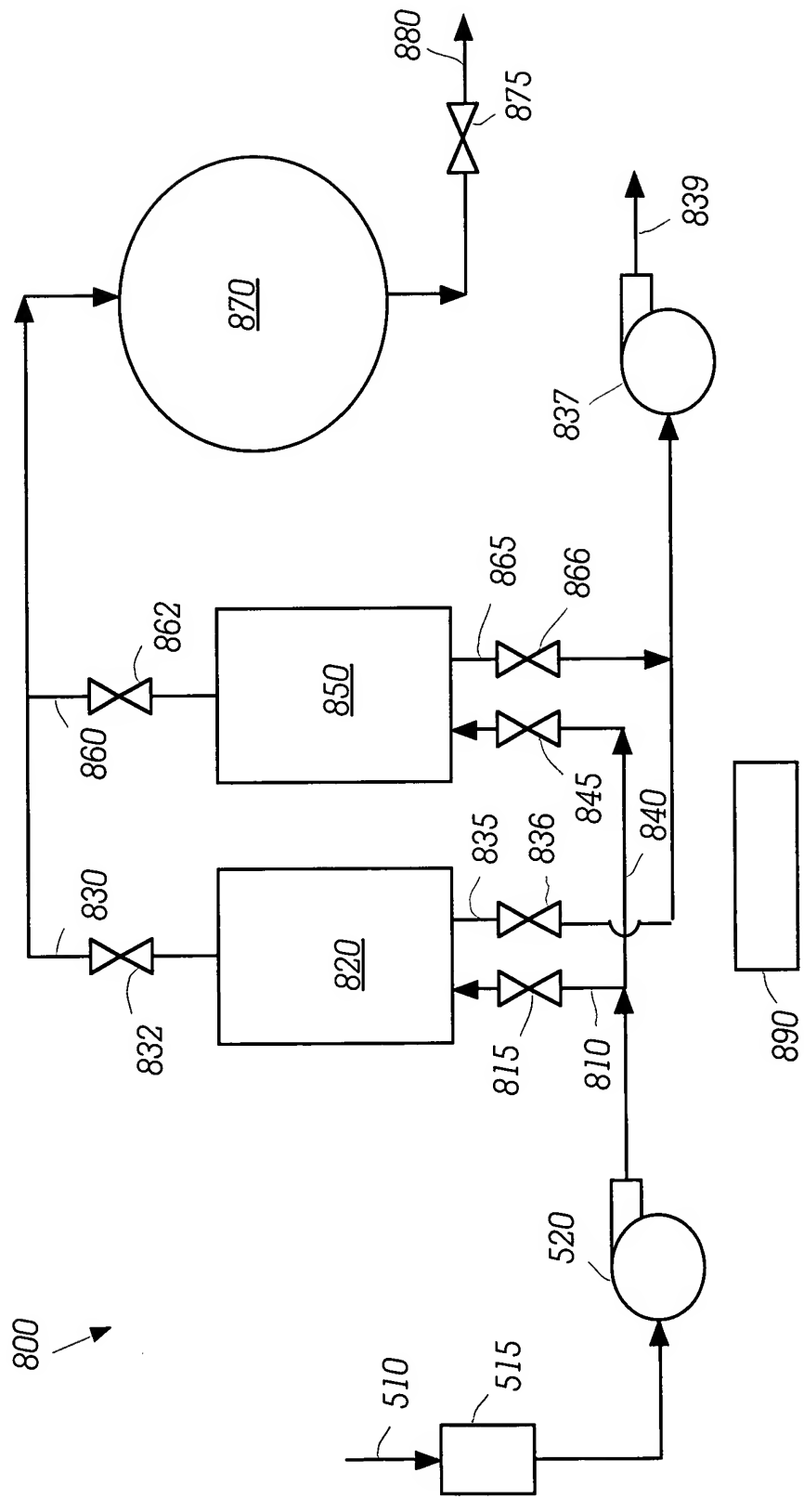


Fig. 15

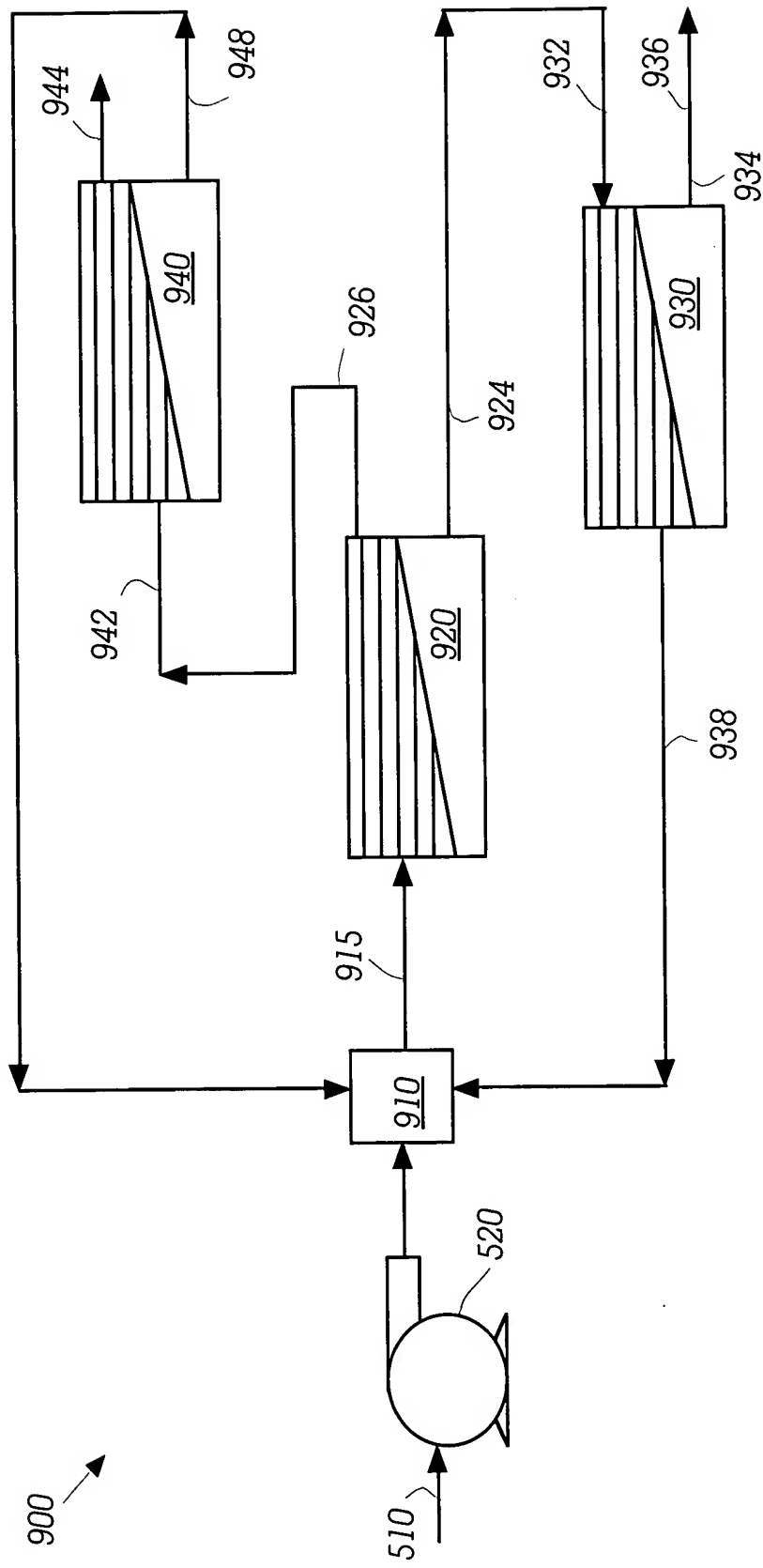


Fig. 16

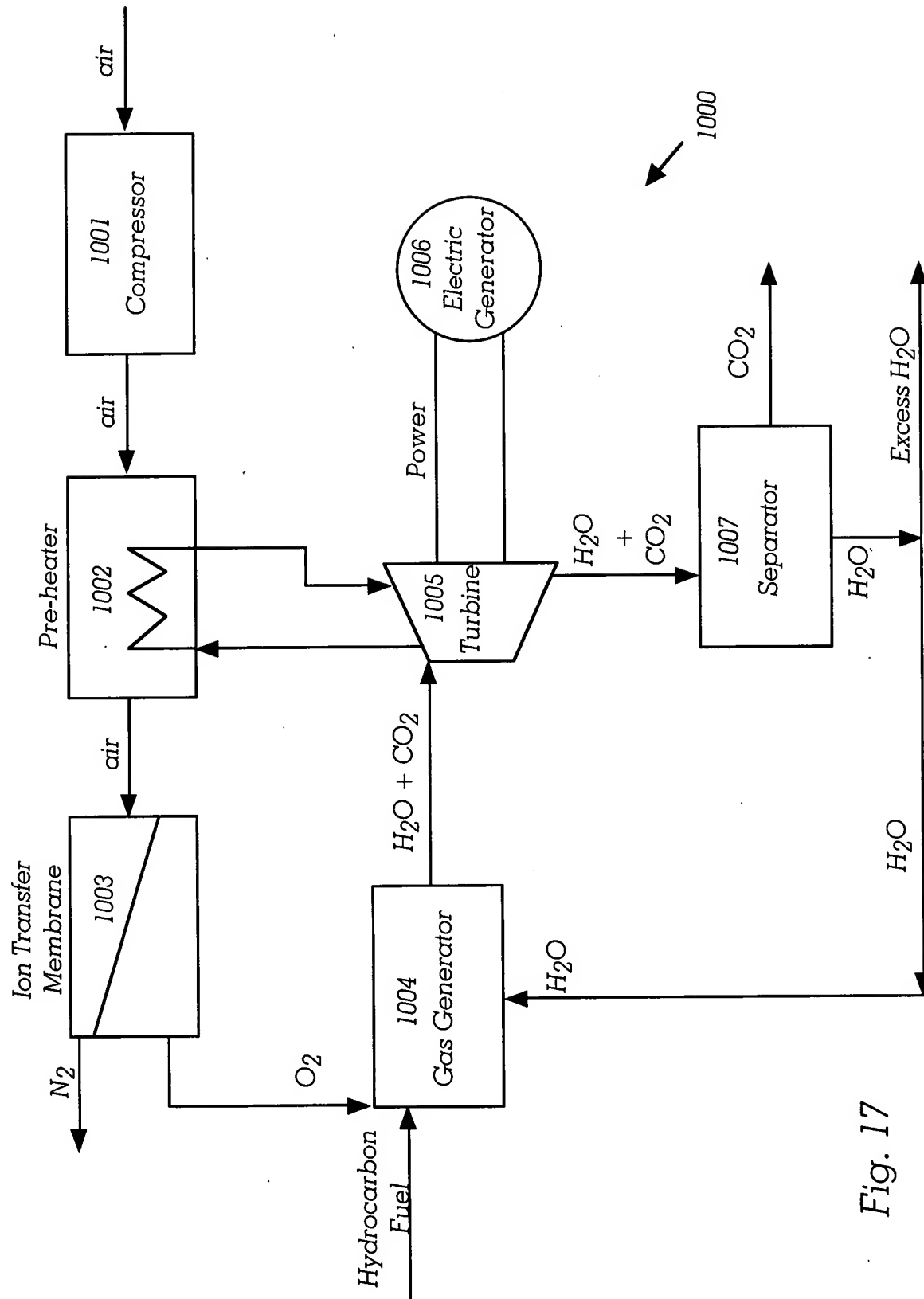


Fig. 17



# INTEGRATED CES POWER PLANT WITH ION TRANSFER MEMBRANE OXYGEN SEPARATION PLANT

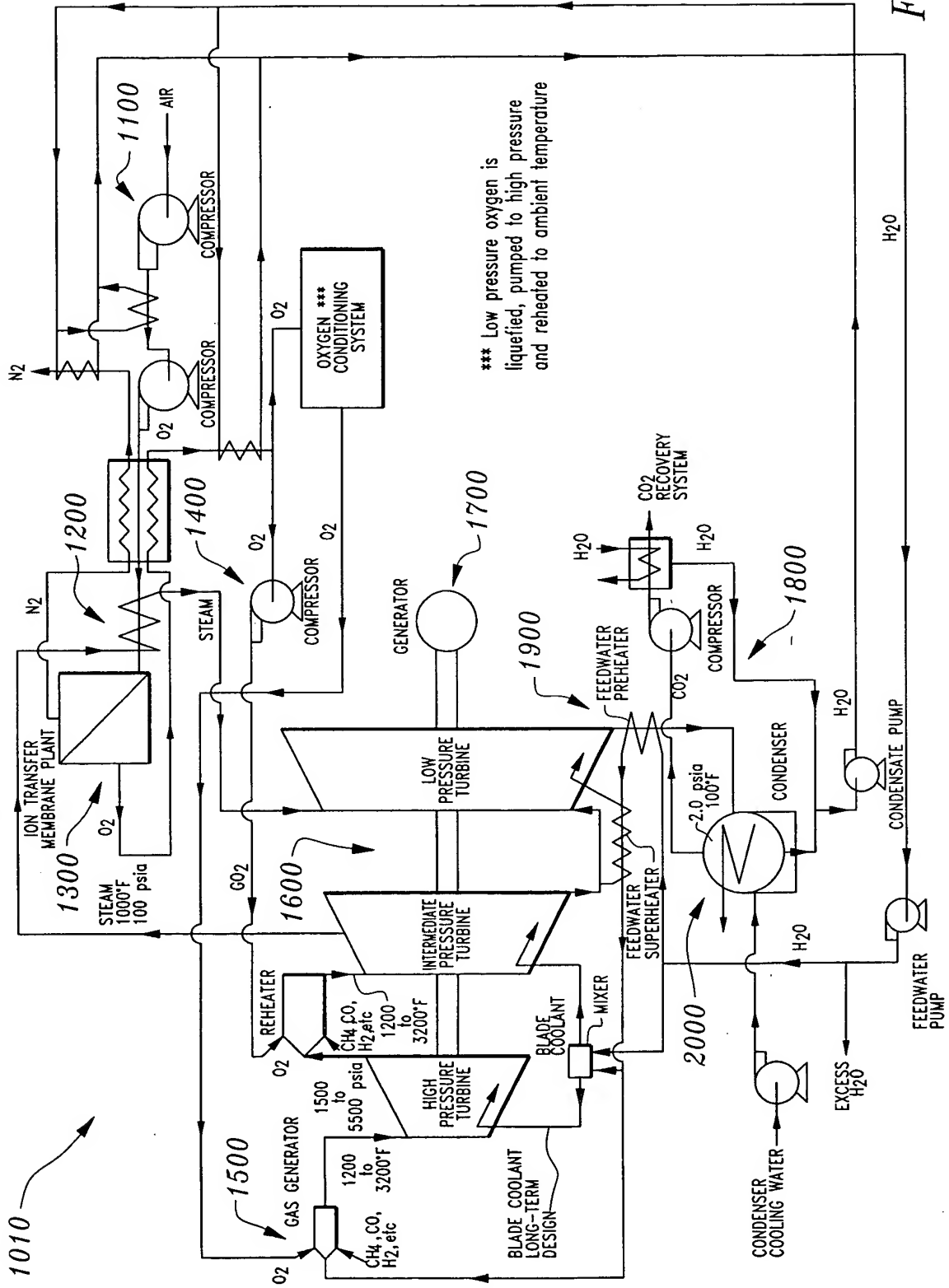


Fig. 18

+



Fig. 19



# CALCULATED HEATING VALUES AND FLOW RATES OF ONE TYPICAL SYN-GAS FROM A 300 TON/DAY MSW GASIFICATION SYSTEM

Wet Basis Composition, Flow Rates, and Heating Values [1]									
Component	Flow Rate		Concentration		Heat of Combustion (LHV)		Heat of Combustion (HHV)		
	m <sup>3</sup> /hr [2]	kg·mol/hr	kg/hr	%vol	%wt	kJ/kg·mol	kJ/hr	kJ/m <sup>3</sup> (NTP)	kJ/kg·mol
H <sub>2</sub>	3463.6	141.567	285.38	57.338	7.657	-241,826	-34,234,736		-285,840
CO <sub>2</sub>	1067.4	43.628	1920.05	17.670	51.516	0	0		0
CO	995.2	40.677	1139.37	16.475	30.570	-282,989	-11,511,081		-282,989
H <sub>2</sub> O	444.1	18.152	327.01	7.352	8.774	0	0		-44,014
CH <sub>4</sub>	51.7	2.113	33.90	0.856	0.910	-802,320	-1,695,405		-890,347
N <sub>2</sub>	18.3	0.748	20.95	0.303	0.562	0	0		0
C <sub>2</sub> H <sub>4</sub>	0.4	0.016	0.46	0.007	0.012	-1,322,960	-21,629		-1,410,987
TOTAL	6040.7	246.901	3727.12	100.00	100.00		-47,462,852	-7,857.2	-54,680,113
							13184.1kW		15188.9kW

Dry Basis Composition, Flow Rates, and Heating Values [1]									
Component	Flow Rate		Concentration		Heat of Combustion (LHV)		Heat of Combustion (HHV)		
	m <sup>3</sup> /hr [2]	kg·mol/hr	kg/hr	%vol	%wt	kJ/kg·mol	kJ/hr	kJ/m <sup>3</sup> (NTP)	kJ/kg·mol
H <sub>2</sub>	3463.6	141.567	285.38	61.888	8.393	-241,826	-34,234,736		-285,840
CO <sub>2</sub>	1067.4	43.628	1920.05	19.072	56.470	0	0		0
CO	995.2	40.677	1139.37	17.782	33.510	-282,989	-11,511,081		-282,989
CH <sub>4</sub>	51.7	2.113	33.90	0.924	0.997	-802,320	-1,695,405		-890,347
N <sub>2</sub>	18.3	0.748	20.95	0.327	0.616	0	0		0
C <sub>2</sub> H <sub>4</sub>	0.4	0.016	0.46	0.007	0.013	-1,322,960	-21,629		-1,410,987
TOTAL	5596.6	228.749	3400.11	100.00	100.00		-47,462,851.82	-8480.7	-53,881,192.92
							13184.1kW		14967.0kW

[1] Heating values based upon assumption that all reactants and products enter and leave at 25°C and 1 atmosphere

[2] Normal temperature and pressure assumed to be 25°C and 1 atmosphere

Fig. 21

POWER PLANT OPERATION ON SYNGAS AND WITH ONE REHEATER  
OPERATING PARAMETERS (SEE Fig. 19)

POSITION	PRESSURE lb/in <sup>2</sup>	TEMPERATURE ° F	FLOW RATE lb/sec.	POSITION	PRESSURE lb/in <sup>2</sup>	TEMPERATURE ° F	FLOW RATE lb/sec.
A	50	72	2.054	AA	2.1	192.9	10.51
B	105	228.5	2.054	AB	1550	151.7	6.674
C	100	84.77	2.054	AC	1630	109.7	6.674
D	210	244.5	2.054	AD	19.7	82.91	2.305
E	210	244.5	0.2283	AE	20.8	287.5	2.358
F	200	87.21	0.2283	AF	6.3	79.38	2.358
G	560	317.7	0.2283	AG	6.5	265.9	2.564
H	532	98.3	0.2283	AH	2.3	81.95	2.564
I	1480	245	0.2283	AI	2.4	141.1	3.716
J	30	72	1.783	AJ	2	127.5	10.51
K	78.8	291.9	1.783	AK	2	108.3	3.716
L	75	94.21	1.783	AL	19.7	82.91	0.053
M	210	399.4	1.783	AM	6.3	79.38	0.2066
N	210	339.4	0.1982	AN	2.3	81.95	1.152
O	200	101.6	0.1982	AO	2	81.76	1.437
P	560	349.7	0.1982	AP	2	108.3	6.795
Q	532	103.2	0.1982	AQ	2	108.3	6.674
R	1480	404.4	0.1982	AR	2100	287.1	2.279
S	170	1050	10.51	AS	644	85.07	2.279
T	210	339.4	1.585	AT	678	301.2	2.281
U	173	164.7	7.1	AU	210	94.03	2.281
V	182	592.5	7.1	AV	221	308.8	2.288
W	15	511.9	10.51	AW	63.2	89.01	2.288
X	210	244.5	1.826	AX	66.5	294.6	2.305
Y	1200	1050	7.1	AY	644	85.07	0.003
Z	1480	772.8	6.674	AZ	210	94.03	0.007
				BA	63.2	89.01	0.01706

MISCELLANEOUS OPERATING PARAMETERS

INPUT POWER = 12705 [kW] LHV  
 ELECTRICAL POWER GENERATED = 5531 [kW]  
 PARASITIC POWER = 2074 [kW]  
 NET ELECTRICAL POWER = 3458 [kW]  
 LHV THERMAL EFFICIENCY = 0.2721

*Fig. 22*

POWER PLANT OPERATION ON SYNGAS AND WITH ONE REHEATER  
OPERATING PARAMETERS (SEE Fig. 20)

POSITION	PRESSURE lb/in <sup>2</sup>	TEMPERATURE ° F	FLOW RATE lb/sec.	POSITION	PRESSURE lb/in <sup>2</sup>	TEMPERATURE ° F	FLOW RATE lb/sec.
A	50	72	2.054	AA	2.1	710.4	9.469
B	105	228.5	1.791	AB	14.5	1200	9.469
C	100	84.77	1.791	AC	15	1369	8.978
D	210	244.5	1.791	AD	1519	598	5.632
E	210	244.5	0.5339	AE	1480	727	5.632
F	200	87.21	0.5339	AF	14.55	513.3	8.978
G	560	317.7	0.5339	AG	1550	498.3	5.632
H	530	98.3	0.5339	AH	1630	108.1	5.632
I	1480	245	0.5339	AI	19.7	82.59	2.305
J	30	72	1.784	AJ	20.8	286.3	2.356
K	78.8	291.9	1.555	AK	6.3	78.5	2.356
L	75	94.21	1.555	AL	6.5	263.5	2.545
M	210	399.4	1.555	AM	2.3	80.29	2.545
N	210	339.4	0.4635	AN	2.4	139.3	3.557
O	200	101.6	0.4635	AO	2	126.9	9.469
P	560	349.7	0.4635	AP	2	106.6	3.557
Q	530	103.2	0.4635	AQ	19.7	82.59	0.051
R	1480	351.2	0.4635	AR	6.3	78.5	0.1897
S	20	72	0.2284	AS	2.3	80.29	1.011
T	170	2200	8.978	AT	2	80.31	1.277
U	210	339.4	1.092	AU	2	106.6	5.913
V	173	611	6.629	AV	2	106.6	5.632
W	182	953.4	6.629	AW	2100	287.1	2.279
X	1200	1500	6.629	AX	644	85.07	2.279
Y	210	244.5	1.257	AY	644	85.07	0.003
Z	20	72	0.263	AZ	678	301.1	2.282
				BA	210	94.01	2.282
				BB	210	94.01	0.007
				BC	221	308.7	2.288
				BD	63.2	88.92	2.288
				BE	63.2	88.92	0.01681
				BF	66.5	294.2	2.305

MISCELLANEOUS OPERATING PARAMETERS

INPUT POWER = 12707 [kW] LHV  
 ELECTRICAL POWER GENERATED = 7847 [kW]  
 PARASITIC POWER = 2132 [kW]  
 NET ELECTRICAL POWER = 5715 [kW]  
 LHV THERMAL EFFICIENCY = 0.4497

*Fig. 23*